

Appendix C: Water Chemistry QA/QC

Field Method Precision

Water chemistry sampling precision was quantified as relative percent difference (RPD) between field duplicates. Field duplicate comparisons are presented in **Table 1**. The QAPP outlined precision and accuracy objectives for field and laboratory duplicates. However, a wider RPD range should be applied to field duplicates than laboratory duplicates for seasonal pools. Field duplicates are highly variable due to the shallow, easily disturbed bottom and biologically rich nature of the pools. As a result, these field duplicates reflect the range of variability for each parameter and determines the representativeness of a sample at a given time in a seasonal pool. Field duplicates objectives were exceeded for the following parameters: color, alkalinity, conductivity, magnesium, chloride and aluminum. In addition, field duplicate and laboratory duplicate objectives for low level samples are typically based on an absolute difference between samples, not as a percentage.

Laboratory Analysis Precision

The laboratory duplicates presented in **Table 2** were used to determine precision. Laboratory duplicate means were within QC objectives. However, one alkalinity duplicate for Hampshire Hill on 06-04-1999 was 17% different. The duplicate value was not included in the final data set. It was determined to be inconsistent with all other results for this pool. Laboratory anion duplicates were not performed on specified seasonal pool samples. Instead, laboratory duplicates performed concurrently within the same analytical run have been used to determine precision.

Laboratory Analysis Accuracy

Accuracy is expressed as percent recovery or percent bias and is determined from the analysis of quality control reference samples that differ from the calibration standard. Due to very low anion concentrations, accuracy of the anion analysis was determined by calculating percent bias of internal spike standards. During 1999, these standards were analyzed concurrently with the water samples. In 2000, these were calculated directly from seasonal pool samples. See **Table 3** for percent recovery results. The mean % recovery and the % bias were within QC objectives for all parameters.

Table 1. Field duplicate comparison on water chemistry

Site	(mg/L)			K (mg/L)			Mg (mg/L)			Na (mg/L)			Al (ug/L)		
	A	B	%diff	A	B	%diff	A	B	%diff	A	B	%diff	A	B	%diff
Bald Mtn North	2.7	2.6	4.14	0.22	0.20	9.52	0.84	0.81	3.64	0.52	0.50	3.92	96.0	96.5	0.52
Boyer	27.5	28.4	3.22	0.24	0.26	8.00	3.41	3.49	2.32	<0.20	<0.20	0.00	--	--	--
Shaw Mtn West	40.9	41.5	1.46	0.19	0.19	0.00	18.5	18.4	0.54	<0.20	<0.20	0.00	--	--	--
Thistle Hill	2.8	2.8	1.07	0.35	0.37	5.56	0.46	0.44	4.44	0.53	0.56	5.50	127.0	140.0	9.74
Woodstock	36.0	36.2	0.55	1.78	1.82	2.22	3.18	3.15	0.95	0.75	0.80	6.45	--	--	--
Dartmouth	6.97	6.32	9.78	2.12	2.11	0.47	0.65	0.572	12.77	<0.20	<0.20	0.00	--	--	--
Irish Hill South	18	17.9	0.56	0.331	0.31	6.55	1.55	1.54	0.65	0.42	0.44	4.65	--	--	--
Mean			2.97			4.62			3.62			2.93			5.13

Bold indicates exceedence of QC objectives.

Table 1. Field Duplicate comparison on water chemistry (continued)

Site	Color (Pt-Co)			Field pH (Std units)			Lab pH (Std units)			Alkalinity (mg/L CaCO ₃)			Conductivity (umhos/cm)		
	A	B	%diff	A	B	%diff	A	B	%diff	A	B	%diff	A	B	%diff
Bald Mtn North	71	72	1.40	5.69	5.61	1.42	6.01	6.17	2.63	5.4	5.6	3.64	25.8	25.2	2.35
Boyer	136	120	12.50	7.15	7.05	1.41	6.92	7.00	1.15	77.2	76.7	0.65	152.0	154.0	1.31
Shaw Mtn West	105	104	0.96	7.07	7.13	0.85	7.31	7.37	0.82	173.0	173.0	0.00	316.0	315.0	0.32
Thistle Hill	67	71	5.80	5.49	5.46	0.55	5.97	6.02	0.83	6.0	5.9	1.68	23.9	24.8	3.70
Woodstock	7.3	5	37.40	7.41	7.45	0.54	7.24	7.23	0.14	100	92.8	7.47	202	197	2.51
Dartmouth	200	220	9.52	6.11	6.12	0.16	6.52	6.50	0.31	17.4	30.0	53.16	39.9	40.8	2.23
Irish Hill South	88	75	15.95	7.29	7.25	0.55	7.38	7.39	0.14	51.9	51.6	0.58	99	100	1.01
Mean			11.9			0.78			0.86			9.60			1.92

Bold indicates exceedence of QC objectives

Table 1. Field duplicate comparison on water chemistry (continued)

Site	Cl (mg/L)			NO ₃ (mg/L)			SO ₄ (mg/L)		
	A	B	%diff	A	B	%diff	A	B	%diff
Bald Mtn North	0.30	0.26	14.29	<0.02	<0.02	0.00	3.29	3.31	0.61
Boyer	0.16	0.14	13.33	<0.02	<0.02	0.00	3.08	3.02	1.97
Shaw Mtn West	0.06	0.05	18.18	<0.02	<0.02	0.00	1.72	1.72	0.00
Thistle Hill	0.45	0.44	2.25	<0.02	<0.02	0.00	2.72	2.79	2.54
Woodstock	0.69	0.70	1.44	<0.02	<0.02	0.00	11.8	11.7	0.85
Dartmouth	0.06	0.05	18.18	<0.02	<0.02	0.00	0.36	0.36	0.00
Irish Hill South	0.28	0.27	3.64	<0.02	<0.02	0.00	5.28	5.18	1.91
Mean			10.19			0.00			1.13

Table 2. Lab duplicate comparison on water chemistry

Site	Lab ID	Lab pH (Std units)		Alkalinity (mg/L CaCO ₃)		Conductivity (umhos/cm)	
		Mean	%diff	Mean	%diff	Mean	%diff
Hampshire Hill	38580	--	--	--	--	16.2	2
Ball Mountain	39167	--	--	--	--	19.4	0
Hobart Spruce	39756	5.54	0	2.3	0	19.3	1
Hampshire Hill	39236	--	--	7.1	17	--	--
Bald Mtn South	45466	5.72	0	8.0	1	--	--
Dartmouth	45693	7.18	0	13.2	3	--	--
Dorset	46016	7.58	1	205	0	--	--
Carleton	46242	7.40	0	82.8	1	--	--
Woodstock	45215	--	--	--	--	202	0
Shaw Mtn East	45589	--	--	--	--	298	0
Bald Mtn North	46315	--	--	--	--	30.2	4
Mean			0.2		3.7		1.2

Bold indicates exceedence of QC objectives.

Table 2 (cont). Lab Duplicate comparison on water chemistry (cations)

Site	Lab ID	Ca (mg/L)		K (mg/L)		Mg (mg/L)		Na (mg/L)		Al (ug/L)	
		mean	%diff	mean	%diff	mean	%diff	mean	%diff	mean	%diff
Hobart Spruce	39756	1.12	1	1.28	1	0.251	15	0.58	3	1250	1
Bald Mtn South	39088	6.22	1	1.41	1	1.36	3	0.78	3	123	2
Whitcher	38861	8.08	0	2.76	0	0.498	0	0.58	0	396	2
Ball Mountain	38533	1.33	1	0.762	-	0.340	1	0.53	1	--	--
Hughes	45694	1.58	1	0.520	1	0.476	0	0.75	1	571	2
Arms Grant	45865	26.2	0	0.889	0	15.0	1	1.12	1	--	--
Maidstone	46067	2.64	1	1.55	0	0.594	1	0.22	5	178	1
Shw Mtn West	45588	14.7	2	0.388	1	18.2	0	0.31	1	--	--
Mean			0.9		0.6		2.6		1.9		1.6

Table 2 (cont). Lab duplicate comparison on water chemistry (anions)*

Date of analysis	Cl %diff	NO ₃ %diff	SO ₄ %diff
04/27/1999	0.00	0.00	0.87
05/26/1999	0.00	0.00	6.01
05/28/1999	0.00	--	0.00
05/28/1999	--	--	0.00
07/29/1999	0.00	0.00	0.00
04/07/2000	--	2.23	1.79
04/07/2000	2.20	--	0.09
05/24/2000	0.00	0.00	0.00
Mean	0.37	0.45	1.10

* Data from samples run concurrently with project samples.

Table 3. Percent Recovery of Spikes on water chemistry

Sample #	Site	Cl	NO ₃	SO ₄	Al	Ca	Mg	K	Na
37811	*	--	109	--	--	--	--	--	--
37956	*	92	--	104	--	--	--	--	--
38058	*	105	113	98	--	--	--	--	--
38097	*	--	95	98	--	--	--	--	--
38580	*	--	--	100	--	--	--	--	--
38765	*	104	103	97	--	--	--	--	--
39087	*	94	--	115	--	--	--	--	--
39088	Bald Mtn South	--	--	--	92	100	101	99	99
38580	Hampshire Hill	--	--	--	--	98	99	103	99
38861	Whitcher Mtn	--	--	--	104	85	100	98	100
39756	Hobart Spruce	--	--	--	103	109	105	105	107
45694	Hughes	103	109	105	96	98	99	103	103
45865	Arms Grant	103	88	104	--	97	96	104	101
46067	Maidstone	103	103	96	98	104	105	103	104
46316	Bald Mtn South	97	103	102	96	128	112	99	110
Mean		100.1	102.9	101.9	98.2	102.4	102.1	101.8	102.9
%Bias		+0.1	+2.9	+1.9	-1.8	+2.4	+2.1	+1.8	+2.9

- Data from samples run concurrently with project samples.

Appendix D

Northern White Cedar Swamp Site Reports

**Northern White Cedar Swamps of Vermont
Vermont Agency of Natural Resources, 2003**

SITE NAME: Martell Swamp

TOWN: Woodbury

MAPS: Cabot, VT 7.5' U.S.G.S. topographic map

LOCATION: 1,250 meters northwest of Nichols Pond in Woodbury

SOURCE OF INFORMATION: Site visits on 6/8/99, 6/10/99, 6/15/99, 7/1/99, and 9/27/99 by E. Sorenson and J. Rykken

OWNERSHIP: Private. No access without permission of landowner.

SIGNIFICANCE:

1. State-significant (B-ranked) example of a northern white cedar swamp.
2. Population of the rare moss *Calliergon richardsonii*.

PHYSICAL SETTING: The 22 hectare (54 acre) Martell Swamp is located in a rather steep sided basin with drainage to the north. A stream originates approximately 900 meters to the south of the swamp and flows through the swamp in a northerly direction, draining into Nichols Brook and eventually the Lamoille River. Martell Swamp occurs in an area underlain by the Waits River formation, bedrock with calcium-rich schists and phyllites.

SURROUNDING LANDSCAPE CONDITION: Martell Swamp is located in a large area of forest (approximately 15 square kilometers) that is unfragmented by paved or gravel roads. This forested block is actively managed for timber products and roads are narrow and not maintained in the winter. There has been some timber harvesting along the north edges of the swamp and approximately 1 ha of the swamp has also been cut.

VEGETATION: The southern end of Martell Swamp has very little evidence of recent human disturbance and has a 75 to 80 percent closed canopy dominated by mature northern white cedar (*Thuja occidentalis*) with lesser amounts of balsam fir (*Abies balsamea*), black ash (*Fraxinus nigra*), and yellow birch (*Betula alleghaniensis*). The average diameter at breast height of cedar trees is about 40 cm, and there many leaning trees, a typical condition in mature cedar swamps. Most of the trees grow on the well developed hummocks.

Shrub cover is only about 10 percent cover and is made up primarily of Canada honeysuckle (*Lonicera canadensis*), mountain holly (*Nemopanthus mucronatus*), mountain maple (*Acer spicatum*), and tree species regeneration. The herb layer covers about 30 percent and includes naked miterwort (*Mitella nuda*), cinnamon fern (*Osmunda cinnamomea*), common wood sorrel (*Oxalis acetocella*), and three-seeded sedge (*Carex trisperma*). Bryophyte cover is high (80%) and includes stair-step moss (*Hylocomnium splendens*) and shaggy moss (*Rhytidiadelphus triquetrus*) on hummocks, the liverwort *Bazzania trilobata* on old stumps and rotting wood, and *Calliergon cordifolium* and *Fissidens* sp. In wet hollows.

The northern end of Martell Swamp is in very different condition, with heavy logging to its margin and an area of about one hectare in which the canopy of cedar has been mostly removed. Approximately 20 percent canopy remains in this small cut, dominated by small diameter cedar and lesser amounts of black ash and red maple (*Acer rubrum*). The shrub layer has responded to the increased light conditions and covers nearly 30 percent and includes tree species regeneration as well as speckled alder (*Alnus incana*), Canada honeysuckle, red-osier dogwood (*Cornus sericea*), and wild raisin (*Viburnum cassinoides*).

Additional shrub species here that are associated with the logging disturbance include raspberry (*Rubus idaeus*) and willow (*Salix* sp.). Similarly, herb density has exploded as a result of the increased light conditions and occupies approximately 95 percent cover. Typical herbs of cedar swamps are present, but a host of additional species not commonly found in undisturbed cedar swamps are dominant, including purple-stemmed aster (*Aster puniceus*), rice cut-grass (*Leersia oryzoides*), arrow-leaved tearthumb (*Polygonum sagittatum*), Joe-pye weed (*Eupatorium maculatum*), marsh purslane (*Ludwigia palustris*), common cattail (*Typha latifolia*), and woolgrass (*Scirpus cyperinus*). Typical mosses occur in the area that has been harvested, but also the rare moss *Calliergon richardsonii* occurs here in the wet hollows. It is unknown how widespread this species is in the swamp and whether it will persist in the open areas created by recent logging.

PHYSICAL AND CHEMICAL CHARACTERISTICS:

The organic soils in the swamp are well-decomposed, but still include abundant wood fragments. Organic soil depths range from over 125 cm at the south end of the swamp to 50 cm at the north end. The presence of wood fragments throughout the profile indicates that the wetland has been forested for a long time, likely several thousand years. The surface water pH was consistent throughout the swamp at 6.4, as was the conductivity (60 μ S).

MACROINVERTEBRATE USE:

(July 1, 1999)–J. Rykken

Impaired site (southern end is less disturbed).

This cedar swamp lies in a narrow valley and is associated with a stream, so I did find some aquatic microhabitats to sample. The northern end of this swamp has been logged fairly recently, the southern end is more intact. The stream flowing through the valley divides into many braided channels within the swamp. Three sites were sampled for aquatic macroinvertebrate: two barely-flowing channels were sampled in the northern end of the swamp; a 0.6 m x 0.6 m hollow at the base of a large boulder in an intact part of the cedar swamp; and in a slow-flowing channel at the southern end of the swamp, just north of a large, open sedge-shrub marsh. Sampling was purely qualitative, and consisted of multiple sweeps with a D-frame net. This site allowed the collection of a considerable number of diverse aquatic insects as it consisted of a stream channel with riffles, pools and hollows. The taxa list for this swamp is presented below in Table 1, divided into the four areas sampled.



The communities collected from the four sites showed some signs of preference based on habitat suitability, i.e riffle beetles were found exclusively in stream riffles. More orders typically associated with flowing waters were found here than found at seasonal pools. Mosquitoes found with regularity at the seasonal pools were not collected probably due to the summer sampling period or flowing waters. The dominant community were dipterans and most of these were non-biting midges.

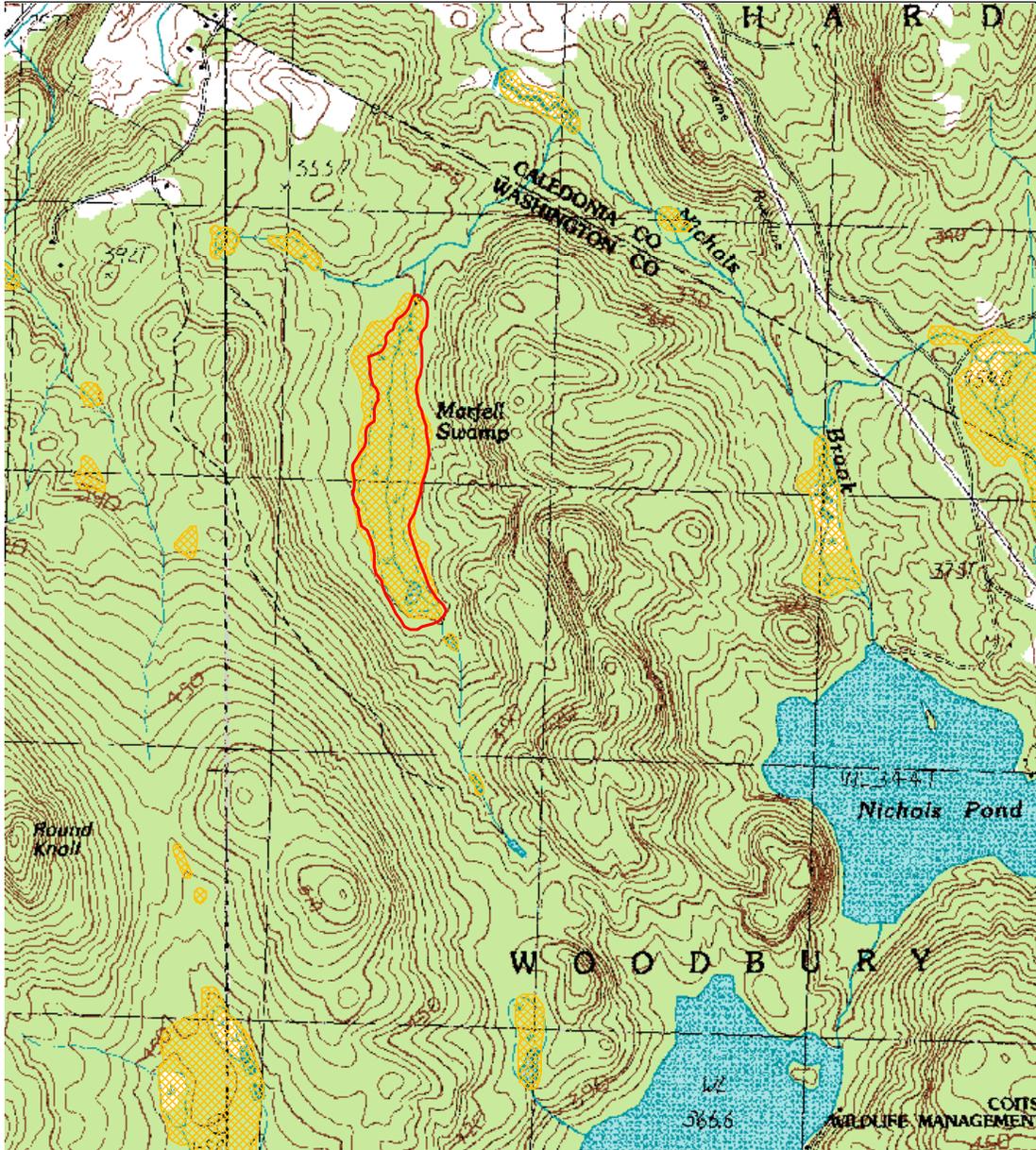
MANAGEMENT RECOMMENDATIONS:

Martell Swamp is an exemplary cedar both for the excellent condition of the southern part of the swamp and for the very high quality, unfragmented landscape in which it occurs. The patch cuts at the northern end of the swamp have resulted in establishment of a suite of species that are uncharacteristic of cedar swamps. Although no invasive exotic plants were observed, the potential for introduction is clear. It is recommended that there be no further timber harvesting in the swamp or an adjacent 50 meter buffer in order to maintain the high quality of the southern portion and allow the northern portion to mature. If logging in the swamp is a specific interest of the landowner, it is recommended that it occur only during well frozen soil conditions and that selective harvesting methods be used that maintain at least 50 percent canopy cover.

Table 1. Martell Northern White Cedar Swamp Taxa list.

Order	Genera	Species	Martell Cedar Swamp A	Martell Cedar Swamp B	Martell Cedar Swamp C	Martell Cedar Swamp D	
BIVALVIA	PISIDIUM	casertanum	17	9	9	2	
		sp		10			
		ventricosum		13			
BIVALVIA Total			17	32	9	2	
COLEOPTERA	AGABUS	sp			1		
	CYMBIODYTA	vindicata			2		
	HYDRAENA	sp		1			
	HYDROPHILIDAE	unid			1		
	HYDROPORUS	sp			1		
	NEOPORUS	sp				1	
	SCIRTES	sp			1		
	STENELMIS	crenata				2	
	STENELMIS	sp				1	
COLEOPTERA Total				1	6	4	
DIPTERA	ABLABESMYIA	sp	3	14	3	6	
	BEZZIA	group	1				
	BRILLIA	sp	2				
	BRYOPHAENOCLADIUS	sp				1	
	CHIRONOMUS	sp			7	1	
	CHRYSOPS	sp	4	3			
	CRICOTOPUS	flavocinctus		1			
	DIXELLA	sp			1		
	EPOICOCCLADIUS	sp				1	
	EUCORETHRA	underwoodi			3		
	HETEROTRISSOCLADIUS	sp	5				
	HEXATOMA	sp				1	
	LABRUNDINIA	sp	30	7			
	LARSIA	sp	2	4			
	MICROPSECTANYTARSUS	unid	8	26	129	6	
	MICROTENDIPES	sp	7	33		2	
	MOCHLONYX	sp			42		
	NANOCLADIUS	sp		5			
	PARAMETRIOCNEMUS	sp	5	2			
	PARATANYTARSUS	sp		1			
	PHAENOPSECTRA	sp	1	2			
	POLYPEDILUM	illionoense tritum	1	3		1	
					1		
	PROCLADIUS	sp	2	4		2	
	PSECTROCLADIUS	sp		2			
	PSEUDOLIMNOPHILA	sp		2		2	
	STEMPELLINELLA	sp		2			
	THIENEMANNEMYIA	group	98	41	11	33	
	THIENEMANNIELLA	xena		2			
	ZAVRELIMYIA	sp		6	3		
	DIPTERA Total			169	160	200	56

Order	Genera	Species	Martell Cedar Swamp A	Martell Cedar Swamp B	Martell Cedar Swamp C	Martell Cedar Swamp D
EPHEMEROPTERA	BAETIDAE	unid	3	100	3	8
	EPHEMERELLIDAE	unid			1	2
	EURYLOPHELLA	sp	5	8		
	LEPTOPHLEBIIDAE	unid	8	31	5	24
	LITOBANCHA	sp		3		20
EPHEMEROPTERA Total			16	142	9	54
HEMIPTERA	GERRIDAE	unid		1		
	GERRIS	sp		1		
	MICROVELIA	sp	2	1	1	
	RHAGOVELIA	sp				1
HEMIPTERA Total			2	3	1	1
HIRUDINEA	GLOSSIPHONIA	complanata		1		
	GLOSSIPHONIIDAE	unid	3	1		
	HELOBDELLA	stagnalis				1
	UNID			7		
HIRUDINEA Total			3	9		1
MEGALOPTERA	SIALIS	sp	1		1	
MEGALOPTERA Total			1		1	
ODONATA	AESHNA	sp tuberculifera		1		3
	BOYERIA	vinosa		1		
	CORDULEGASTER	maculatus				6
	UNID			1		
ODONATA Total				3		9
OLIGOCHAETA	LUMBRICULUS	variegatus			3	
	TUBIFEX	tubifex			1	
OLIGOCHAETA Total					4	
PLECOPTERA	LEUCTRA	sp				2
	LEUCTRIDAE	imm	10			
PLECOPTERA Total			10			2
TRICHOPTERA	LEPIDOSTOMA	sp				1
	MOLANNA	uniophila	2			1
	OLIGOSTOMIS	sp	3			1
	PYCNOPSYCHE	sp	1			1
TRICHOPTERA Total			6			4



 Cedar swamp boundary.shp
 NWI Wetlands



**Martell Swamp
Woodbury, Vermont**

USGS Topographic Map Base



**Northern White Cedar Swamps of Vermont
Vermont Agency of Natural Resources, 2003**

SITE NAME: Berlin Mall Cedar Swamp

TOWN: Berlin

MAPS: Bare West, VT 7.5' U.S.G.S. topographic map

LOCATION: Between Route 62 and the Berlin Mall

SOURCE OF INFORMATION: Site visits on 6/9/99, 6/19/99, 6/22/99, and 9/28/99 by R. Popp, J. Kellogg, K. Lenorovitz, J. Rykken, and E. Sorenson

OWNERSHIP: Private. No access without permission of landowner.

SIGNIFICANCE:

A small, highly disturbed northern white cedar swamp.

PHYSICAL SETTING:

This six acre fragment of northern white cedar swamp is surrounded by a large paved parking lot and a four lane limited access roadway (Route 62). The swamp receives stormwater runoff from these paved areas and drains to the north through culverts and natural streams into the Stevens Branch. This swamp fragment lies south of Route 62, which splits the cedar swamp from the remaining portion to the north of the road. There is an approximately 50 foot long strip of mineral soil fill that extends into the swamp from the north side. Berlin Mall Swamp occurs in an area underlain by the Waits River formation, bedrock with calcium-rich schists and phyllites.

SURROUNDING LANDSCAPE CONDITION:

The area surrounding the swamp is highly fragmented by paved roads and commercial and light industrial development. The swamp itself has been bisected by Route 62, which has also changed drainage patterns.

VEGETATION:

Although this small cedar swamp is surrounded by development, there are parts of the swamp interior that still look very much like most undisturbed swamps in remote settings. The shady interior is dominated by northern white cedar (*Thuja occidentalis*) with lesser amounts of balsam fir (*Abies balsamea*), red spruce (*Picea rubens*), and yellow birch (*Betula alleghaniensis*), and the moss covered hummocks and hollows prevail in the swamp interior. Many typical herbs are present in the swamp, including cinnamon fern (*Osmunda cinnamomea*), three-seeded sedge (*Carex trisperma*), dwarf raspberry (*Rubus pubescens*), golden saxifrage (*Chrysosplenium americanum*), water avens (*Geum rivale*). Typical mosses are also present, including *Sphagnum warnstorffii*, *Sphagnum russowii*, stair-step moss (*Hylocomnium splendens*), and the wet hollow species *Calliergon cordifolium*.

There are many differences from this swamp and undisturbed examples, however. The altered hydrology has created areas of open marsh on the western end of the swamp. In the areas that are still cedar swamp, many of the hollows are especially wet and some have no vegetation. There are several species present that are atypical of cedar swamps and reflect the altered hydrology, including frondose beggar's ticks (*Bidens frondosa*), rice cutgrass (*Leersia oryzoides*), common duckweed (*Lemna minor*), and tussock sedge (*Carex stricta*), and the liverwort *Aneura pinguis*. Another species that is not typical of cedar

swamps is the moss *Sphagnum teres*. This species is characteristic of mineral-rich fens and may be here at the Berlin Mall Swamp because of the very high conductivity associated with runoff and the generally open canopy conditions.

PHYSICAL AND CHEMICAL CHARACTERISTICS:

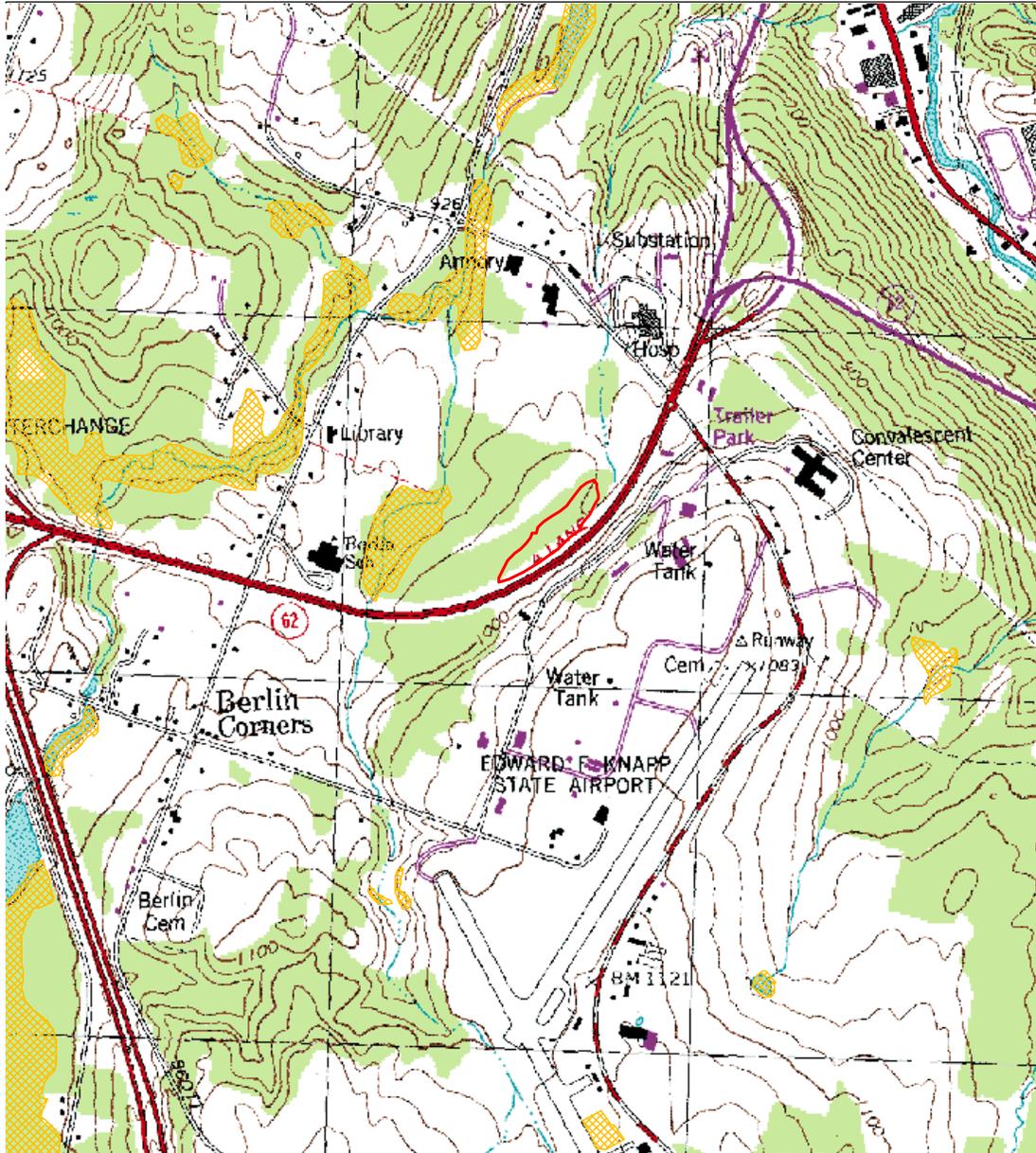
There is only a thin layer (25 cm) of well decomposed organic soils in this swamp. This overlies gleyed silty soil. Surface water pH was 7.2 on September 28, 1999 and conductivity ranged from 480 μ S to 720 μ S in the small swamp.

MACROINVERTEBRATE USE:

This is an impaired site. We found only the part of the swamp south of Route 62. This part of the swamp had no standing/flowing water, so we were not able to sample aquatic macroinvertebrates. There were “hollow” areas under exposed roots that had stained leaves to suggest they had held pools of water earlier in the year, but even these were dry on our visit. We found a dried stream channel at the south end of the swamp, which we may also have been able to sample earlier in the spring.

MANAGEMENT RECOMMENDATIONS:

Although highly disturbed, this small swamp still contributes to the diversity of habitats for plants in this area. The small swamp also provides habitat for several species of nesting birds, including Swamp Sparrow, Song Sparrow, White-throated Sparrow, Winter Wren, Black-capped Chickadee, Veery, and Solitary Vireo. Activities that will help to maintain this swamp include avoiding any future filling in the swamp or clearing of the remaining forested buffer, establishing forested buffer in any locations possible, and pre-treating stormwater before it reaches the swamp.



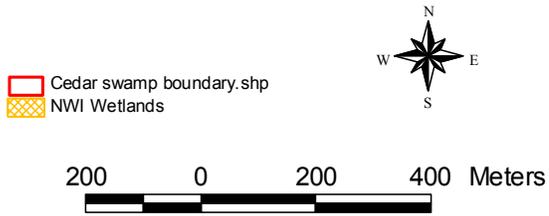
Cedar swamp boundary.shp
 NWI Wetlands



**Berlin Mall Cedar Swamp
Berlin, Vermont**

USGS Topographic Map Base





**Berlin Mall Cedar Swamp
Berlin, Vermont**

1998 Orthophoto Base

**Northern White Cedar Swamps of Vermont
Vermont Agency of Natural Resources, 2003**

SITE NAME: Calendar Brook Cedar Swamp

TOWN: Sutton

MAPS: Sutton, VT 7.5' U.S.G.S. topographic map

LOCATION: 2.1 miles west of Sutton village on Sheffield Road the Wildlife Management Area in on the north, just past powerlines.

SOURCE OF INFORMATION: Site visits on 6/11/99, 6/22/99, and 10/4/99 by A. Quackenbush and E. Sorenson

OWNERSHIP: Calendar Brook Wildlife Management Area, Vermont Department of Fish and Wildlife, in part. Private, in part. No access to private land without permission of landowner.

SIGNIFICANCE:

1. State-significant (B-ranked) example of a northern white cedar swamp.
2. A population of the rare moss *Calliergon richardsonii*.

PHYSICAL SETTING:

This 120 acre northern white cedar swamp occurs in the flat-bottomed valley where Calendar Brook and a tributary stream join. The swamp is a mixture of Northern White Cedar Sloping Cedar Forest on the gently sloping margins of the valley and typical Northern White Cedar Swamp in the central, flat portions of the swamp. Calendar Brook flows through the valley in a southeasterly direction and enters the West Branch of the Passumpsic River several miles downstream. Calendar Brook Cedar Swamp occurs over the crystalline limestone, schists, and phyllites of the Waits River formation.

SURROUNDING LANDSCAPE CONDITION:

Calendar Brook Swamp is surrounded by country roads, farm fields, small managed woodlots, and to the southwest, the VELCO powerline. Although the surrounding landscape is fragmented by all these uses, the swamp itself is relatively well buffered by upland forest. The cedar swamp grades into the surrounding lowland spruce-fir forest, and those portions that are wet and contain some northern white cedar (*Thuja occidentalis*) have been considered cedar swamp for this report. Stand mapping on the Wildlife Management Area has identified a smaller area of cedar swamp – only 78 acres.

VEGETATION:

Much of the swamp at the Calendar Brook site falls under the classification of Northern White Cedar Sloping Cedar Forest. Northern white cedar (*Thuja occidentalis*) dominated the closed canopy in the less disturbed portions of this swamp type, with dense shade below. The gently sloping, organic rich soils have little microtopography but do have flowing water just beneath the soil surface. Herbaceous and bryophyte cover is sparse. Additional survey work is needed to describe the sloping cedar portion of the swamp.

The typical northern white cedar swamp occurs in the flatter portions of the wetland complex where water accumulates and organic soil layers are deeper. Northern white cedar is the dominant tree, but balsam fir (*Abies balsamea*) is co-dominant in some areas and red spruce (*Picea rubens*) is common. In areas

unaffected by recent logging, canopy cover is approximately 85 percent. All of these tree species as well as black ash (*Fraxinus nigra*) are present in the tall and short shrub layers. Other shrub species include mountain holly (*Nemopanthus mucronatus*), Canada honeysuckle (*Lonicera canadensis*), mountain maple (*Acer spicatum*), and alder-leaved buckthorn (*Rhamnus alnifolia*). Common wood sorrel (*Oxalis acetocella*) dominates the herb layer in many areas, along with the typical boreal herbs, goldthread (*Coptis trifolia*), naked miterwort (*Mitella nuda*), twinflower (*Linnaea borealis*), creeping snowberry (*Gaultheria hispidula*), and bunchberry (*Cornus canadensis*). Bryophytes carpet the hummocks and all but a fraction of the hollows, where there is shallow standing water. The dominant species are shaggy moss (*Rhytidiadelphus triquetrus*) and stairstep moss (*Hylocomnium splendens*) that together covered 80 percent of the swamp floor in the plot. A total of 18 species of mosses and liverworts were recorded in the 200 square meter plot, one of which is the rare moss of cedar swamp hollows, *Calliergon richardsonii*.

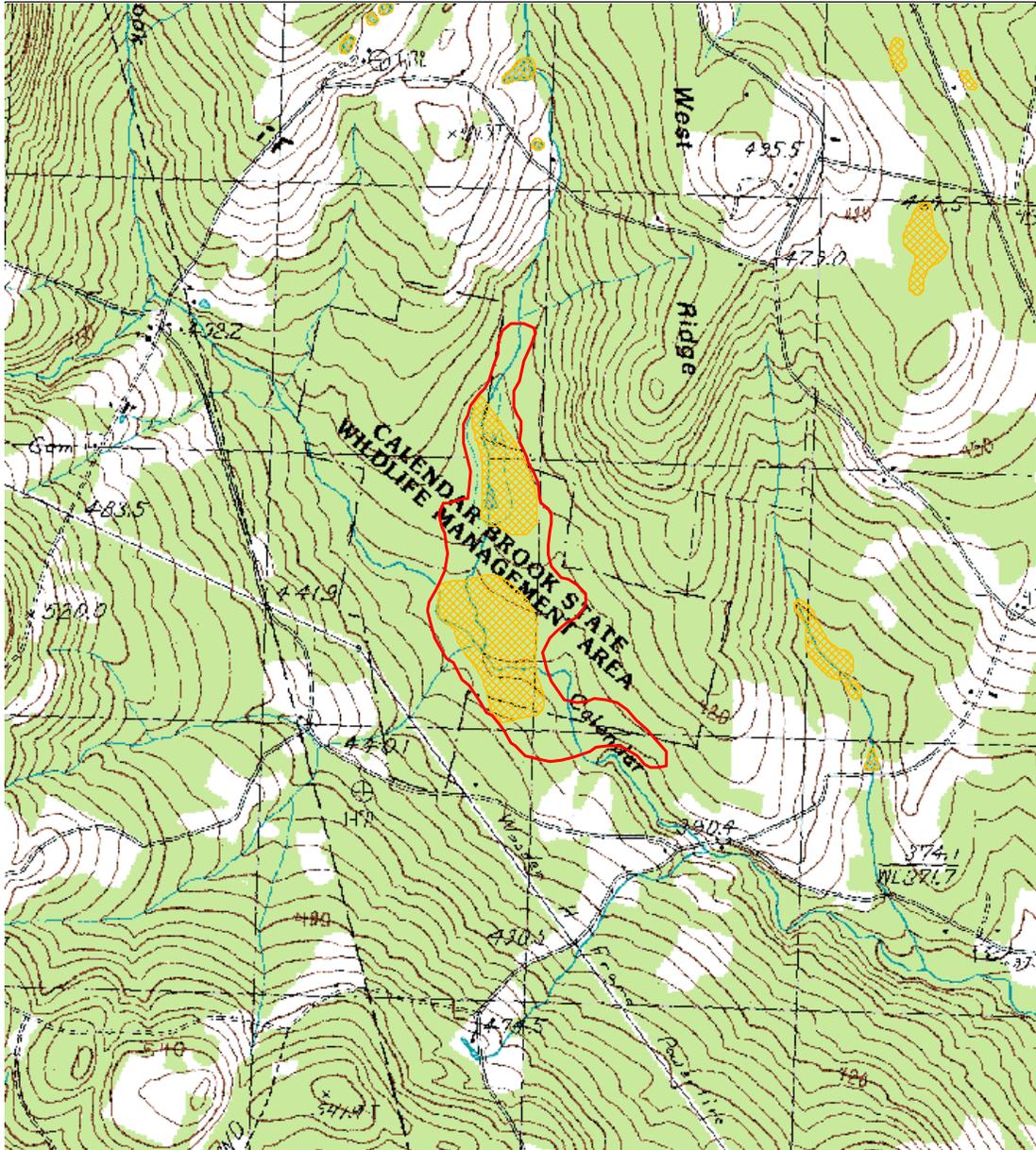
There has been considerable logging in Calendar Brook Swamp in the past 10 to 20 years and no mature areas of swamp were observed. Several small emergent marshes occur along Calendar Brook in the swamp, the result of past beaver activity.

PHYSICAL AND CHEMICAL CHARACTERISTICS:

The organic soils in the swamp range from only 25 cm in the marginal sloping portions to 65 cm in the more central portion of the swamp. The soils are well decomposed but with wood fragments throughout the profile. The organic soil is underlain by gleyed silty, fine sand. Surface water pH was 6.2 and conductivity was 110 μ S.

MANAGEMENT RECOMMENDATIONS:

Calendar Brook Cedar Swamp is sufficiently large to include areas that are actively managed for wildlife habitat and timber and also areas that allowed to mature. There are currently two areas of cedar swamp identified in the management plan for which there will be no active management. If these areas are sufficiently large, this combination of active and passive management will benefit both those wildlife species that utilize mature swamp conditions and those that utilize more early successional swamp conditions. As most of this Wildlife Management Area is a winter deer yard, the current management plan calls for uneven aged management in the portions of the swamp and in all of the adjacent lowland spruce-fir forest on state-owned land.



 Cedar swamp boundary.shp
 NWI Wetlands



**Calendar Brook Swamp
Sutton, Vermont**

USGS Topographic Map Base



**Northern White Cedar Swamps of Vermont
Vermont Agency of Natural Resources, 2003**

SITE NAME: Mollys Brook Swamp

TOWN: Cabot

MAPS: Cabot, VT 7.5' U.S.G.S. topographic map

LOCATION: large wetland complex along Mollys Brook, west of U.S. Route 2, and between South Cabot and East Cabot

SOURCE OF INFORMATION: Site visits on 6/10/99, 6/17/99, and 9/28/99 by B. Engstrom and E. Sorenson

OWNERSHIP: Private. No access without permission of landowner.

SIGNIFICANCE:

1. State-significant (B-ranked) example of a northern white cedar swamp.
2. Populations of the uncommon plants large yellow lady's-slipper (*Cypripedium calceolus* var. *pubescens*) and mountain fly-honeysuckle (*Lonicera villosa*).

PHYSICAL SETTING:

This 125 acre swamp along Mollys Brook includes areas of alder swamp, beaver impoundment, and shallow marsh resulting from past beaver activity. Mollys Brook flows southwest through the swamp and into Mollys Falls Pond about 1.25 miles to the southwest. Mollys Brook flows into the Winooski River in Marshfield. The 2,200 to 2,300 foot hills surrounding Mollys Brook Swamp are granitic – the northern part of the Knox Mountain pluton. However, the calcium-bearing rocks of the Waits River formation surround the Knox Mountain pluton, and the source of the till in the Mollys Brook Swamp watershed includes both granite and this more calcium-rich bedrock.

SURROUNDING LANDSCAPE CONDITION:

As is typical of many of the cedar swamps in the Northern Vermont Piedmont biophysical region, Mollys Brook Swamp is surrounded by paved and gravel roads, agricultural lands, managed woodlots, and rural residential development. A considerable area of the eastern side of the swamp has been cleared of trees for use as pasture and for a powerline that runs along Route 2. There is a buffer of upland forest on the western side of the swamp, but much of this has been selectively, but heavily logged in recent years.

VEGETATION:

Typical Northern White Cedar Swamp occurs in the much of the swamp, with the Northern White Cedar Sloping Cedar Forest variant occurring on the gently sloping margins of the swamp. The typical northern white cedar swamp has a canopy cover of approximately 80 percent, strongly dominated by northern white cedar (*Thuja occidentalis*), with lesser amounts of balsam fir (*Abies balsamea*) and black ash (*Fraxinus nigra*). The tall shrub layer is sparse, composed of tree species regeneration, along with speckled alder (*Alnus incana*) and winterberry (*Ilex verticillata*). The short shrub layer (under 1.25 m) includes these same species, as well as alder-leaved buckthorn (*Rhamnus alnifolia*), red-osier dogwood (*Cornus sericea*), bristly black current (*Ribes lacustre*), Canada honeysuckle (*Lonicera canadensis*), and mountain maple (*Acer spicatum*). This swamp has high species richness, with 65 vascular and bryophyte species identified in the 200 square meter plot – the majority of these are herbs. Herbaceous cover is 60

percent and is dominated by sedges (*Carex trisperma*, *C. leptalea*, *C. disperma*, and *C. interior*), goldthread (*Coptis trifolia*), naked miterwort (*Mitella nuda*), oak fern (*Gymnocarpium dryopteris*), and dwarf raspberry (*Rubus pubescens*). Bryophytes cover approximately 95 percent of the hummocks and hollows, with the only breaks being small pools in the wettest hollows and downed wood. Although 12 species were identified in the plot, stairstep moss (*Hylocomnium splendens*) and shaggy moss (*Rhytidiadelphus triquetrus*) together make up 70 percent of the swamp floor bryophyte carpet.

The areas of northern white cedar sloping cedar forest have a more closed canopy (95 percent cover), are gently sloping, and have little or no shrubs or tall herbs. Cedar and balsam fir dominate the uniform-aged canopy, with the crowns of occasional tall white spruce (*Picea glauca*) extending above. Low herbs occupy about 25 percent cover and are strongly dominated by common wood sorrel (*Oxalis acetocella*), with lesser amounts of dwarf raspberry, pedunculate sedge (*Carex pedunculata*), and intermediate wood fern (*Dryopteris intermedia*). Bryophyte cover is relatively high for this type of cedar swamp, with stairstep moss, shaggy moss, and the liverwort *Bazzania trilobata*.

There has been logging throughout the swamp over the years and no areas of mature swamp were observed. On the western side of the swamp where there has been recent logging in the swamp there are skidder ruts in the soft organic soil that have filled with water. In areas like this and on the eastern side of the swamp where agricultural clearing has occurred, there are many species present that take advantage of these disturbances and are not typically found in mature cedar swamps, if they do occur in mature swamps, occupy very little area. These include common cattail (*Typha latifolia*), common rush (*Juncus effusus*), jewelweed (*Impatiens capensis*), raspberry (*Rubus idaeus*), drooping sedge (*Carex crinita*), and Canada goldenrod (*Solidago canadensis*).

The 125 acre swamp includes about 15 acres of emergent marsh associated with beaver impoundments and alder swamp.

PHYSICAL AND CHEMICAL CHARACTERISTICS:

Organic soil depth ranges from 40 cm in the sloping cedar forest to 125 cm in the flat portions of the basin occupied by the typical northern white cedar swamp. The shallower peats tend to be more highly decomposed than those in the deeper portions of the basin. Wood fragments are present in all of the soil profiles sampled, indicating the long history of forested swamp at this site. Surface water pH was 6.4 and conductivity was 80 μ S.

MANAGEMENT RECOMMENDATIONS:

Mollys Brook Swamp has absorbed a substantial amount of disturbance associated with filling and clearing for road construction, agricultural clearing and grazing, and logging. It is recommended that there be no more clearing of the swamp and that some areas of the swamp be allowed to mature without further logging.

